RWANDA STANDARD

DRS 187

Second edition

2018-mm-dd

(Reaffirmed yyyy)

Rainwater harvesting systems — Code of practice

Rwanda Standards Board

Reference number

RS 187: 2018

In order to match with technological development and to keep continuous progress in industries, standards are subject to periodic review. Users shall ascertain that they are in possession of the latest edition

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Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

RS 187 was prepared by Technical Committee RSB/TC 013, Water and Sanitation.

In the preparation of this standard, reference was made to the following standard:

BS 8515:2009: Rain water harvesting

The assistance derived from the above source is hereby acknowledged with thanks.

This second edition cancels and replaces the first. edition (RS 187: 2013), which has been technically revised

Committee membership

The following organizations were represented on the Technical Committee on Water and Sanitation (RSB/TC 013) in the preparation of this standard.

AQUASAN Ltd

ELECTROMAX

Entreprise URWIBUTSO

Inyange Industries Ltd

JIBU Corporate

Ministry in charge of Emergency management

ROTO Tank Ltd

RULIBA Clays

Rwanda Mines, Petroleum and gas Board (RMB)

Rwanda Utility Regulatory Authority (RURA)

SONATUBE

SULFO Industries

University of Rwanda (UR-CST)

Water and Sanitation Corporation (WASAC)

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Introduction

0.1. General

On-site collection and use of rainwater is an alternative to public mains water supply for a variety of non and potable water uses in the home, workplace and garden. It can also provide benefits for the attenuation of surface water run-off.

As the rainwater harvesting sector expands, there is a need for standardization to protect the public and to ensure that reliable systems are designed, installed and maintained.

0.2. Types of rainwater harvesting

0.2.1 There are three basic types of rainwater harvesting systems (see Figure 1):

a) water collected in storage tank(s) and pumped directly to the points of use;

b) water collected in storage tank(s) and fed by gravity to the points of use; and

c) water collected in storage tank(s), pumped to an elevated cistern and fed by gravity to the points of use.

0.2.2 Within these basic types, there are variations such as:

d) internal or external locations for tanks;

e) single or multiple linked tanks;

f) freestanding or fully or partially buried tanks;

g) communal tanks supplying multiple properties; and

h) packaged systems or components.

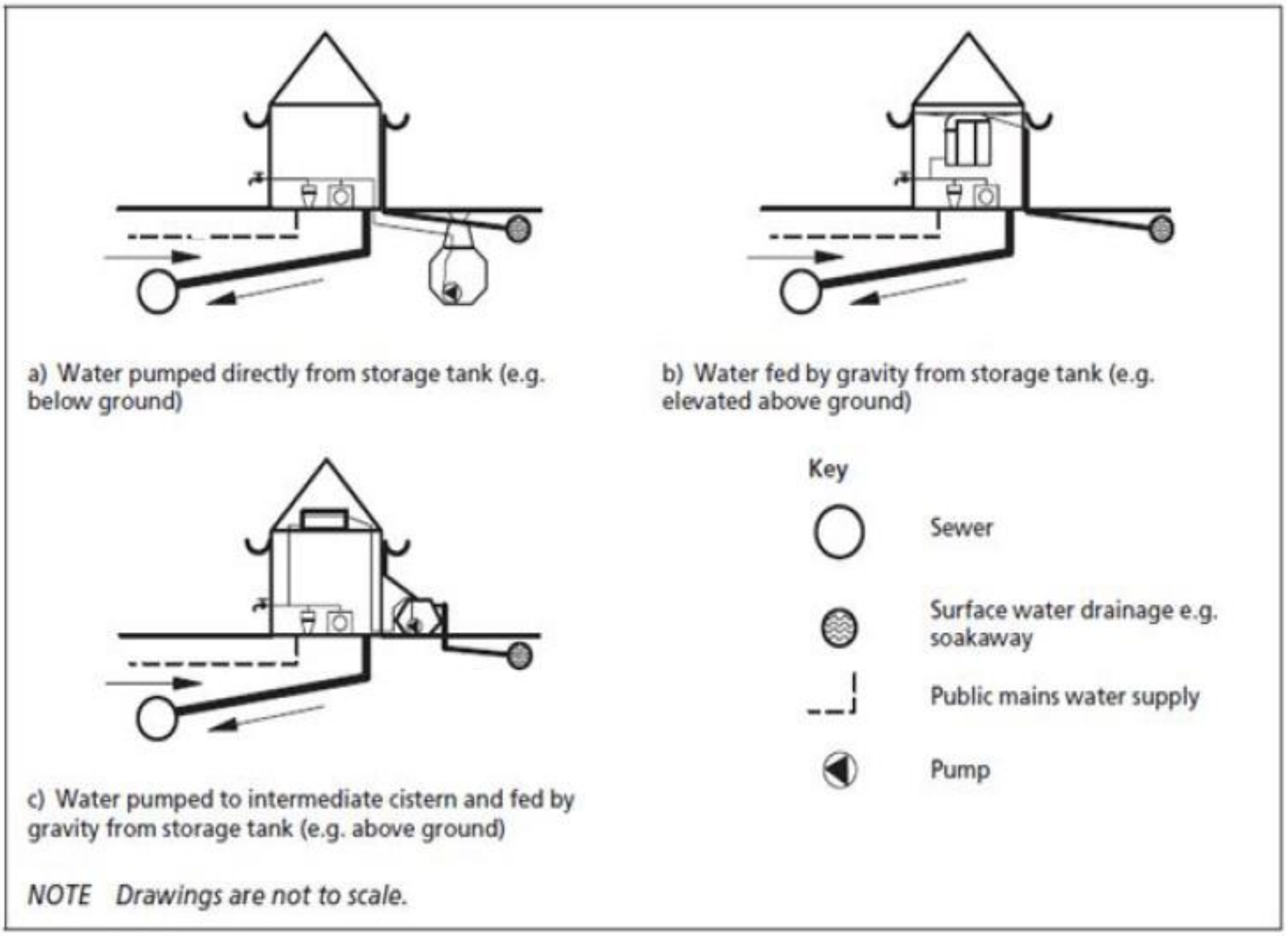

Figure 1 — Outline examples of rainwater harvesting systems

Rainwater harvesting systems — Code of practice

1 Scope

1.1 This Rwanda Standard gives recommendations on the design, installation, testing and maintenance of rainwater harvesting systems in Rwanda.

1.2 It covers systems supplying water for domestic uses (in residential, commercial, industrial or public premises) that do not necessarily require potable water quality such as laundry, WC flushing and garden watering. It may however cover the potable purpose after meeting required standards RS EAS 12 Potable Water-Specification.

1.3 It covers individual and communal systems and those providing stormwater control. It does not cover water butts. It also does not cover product design for specific system components. It applies to retrofitting and new build.

NOTE Although this Standard does not give specific recommendations relating to the use of rainwater for fire suppression or commercial irrigation, these applications are not excluded.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

RS EAS 12 *Potable Water-Specification*

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply.

3.1 air gap

physical break between the lowest level of the water inlet and the maximum fault level or critical level of an appliance or installation, a feed pipe, or an air inlet orifice incorporated into a hydraulic circuit

3.2 anti-surcharge valve

valved device, installed directly in the pipework of a drainage system intended to protect buildings from backflows and flooding from drains or sewers

3.3 backflow

movement of the fluid from downstream to upstream within an installation

3.4 backflow prevention device

device which is intended to prevent contamination of potable water by backflow in a water supply system

3.5 back-up supply

supply of potable water, e.g. from the public mains water supply or private borehole, that can supplement the non-potable supply in times of drought and/or heavy demand

3.6 break cistern

cistern used to separate two plumbing systems of different pressures, water qualities or flow rates, where the water from one system flows through an air gap and into the storage cistern feeding the second system

3.7 calmed inlet

fitting on the end of the drainage pipe feeding the storage tank that minimizes turbulence and slows the water flow into the tank

NOTE The calmed inlet is used to prevent disturbance of any sediments near the base of the tank.

3.8 cistern

fixed container for holding water at atmospheric pressure for subsequent reuse as part of a plumbing system

3.9 control unit

unit which automatically controls and monitors the function of the rainwater harvesting system to facilitate effective operation

3.10 cross-connection

physical hydraulic link or a removable link between two separate systems, which can lead to cross contamination

3.11 dead leg

section of pipework through which no water flows, usually created by closing a pipe after the removal of a terminal fitting

3.12 depression storage

volume of water lost from surfaces, e.g. by evaporation or absorption, before run-off commences

3.13 dip sample

sample of water collected by immersing a container into a body of water and withdrawing it

3.14 domestic use

use related to residential or similar dwellings

NOTE 1 Potable domestic use includes water for the kitchen sink, wash and hand basins, bath, shower and dishwasher. Non-potable domestic use includes water for WC flushing, domestic washing machines and garden watering.

NOTE 2 In commercial, industrial or public premises, “domestic use” is limited to water used for those applications/appliances described above and excludes, for example, water used for firefighting, central heating or irrigation systems.

3.15 infiltration

<into the ground> the movement of surface water or treated effluent into the ground

3.16 green roof

roof covered with vegetation

3.17 nominal capacity

dimensional volume of the maximum capacity of water that can be retained within the tank, e.g. up to the overflow

3.18 non-potable water

any water other than potable water

NOTE Non-potable water can also be referred to as “unwholesome” water.

3.19 overflow

device that relieves the system of excess volume

3.20 point of use

point where water is drawn by the user either directly or by connecting an apparatus

3.21 potable water

water suitable for human consumption

NOTE Potable water can also be referred to as “wholesome” water.

3.22 public mains water

wholesome water supplied by a water undertaker, licensed water supplier

3.23 rainwater

water arising from atmospheric precipitation

3.24 rainwater butt

cask set on end to store rainwater for garden watering

3.25 return period

average period of time within which the depth or intensity of rainfall for a given duration, e.g. 5 min, 24 hr, will be equalled or exceeded once

3.26 soakaway

pit or other drainage arrangement prepared in permeable ground to which surplus surface water is fed and from which it soaks into the ground

3.27 spillover level

level at which water will start to flow over the receiving vessel with all outlets closed

3.28 stormwater control

measures to control the rate and quantity of surface water run-off

3.29 surface water

water from precipitation, which has not seeped into the ground and which is discharged to the drain or sewer system directly from the ground or from exterior building surfaces

3.30 tank

closed, watertight, vented container for rainwater, which forms part of a drainage system

3.31 working capacity

maximum capacity of water that can be extracted from a tank in normal use, e.g. from the overflow to the lowest extraction point

4 Design

4.1 Sizing

4.1.1 General

As the optimum storage capacity for a rainwater harvesting system is a function of the rainwater availability and the non-potable water demand, the following factors should be identified in order to calculate the size of the system:

i) the amount and intensity of rainfall;

j) the size and type of the collection surface; and

k) the number and type of intended applications, both present and future.

4.1.2 Calculation methods

4.1.2.1 General

4.1.2.1.1 The storage capacity of the rainwater harvesting system should be determined using one of the following methods (a simplified approach for residential properties):

a) where there is consistent daily demand, for which no calculations have to be carried out (see 4.1.2.2);

b) an intermediate approach which uses simple formulae to calculate a more accurate estimation of storage capacity than the simplified approach (see 4.1.2.3); and

c) a detailed approach for non-standard systems, where there is variable demand through the year (see 4.1.2.4).

NOTE 1 The simplified approach is not suitable for commercial premises as the assumptions relating to demand are not applicable. The intermediate approach may be used for certain commercial and industrial premises, such as schools and offices.

NOTE 2 For larger rainwater harvesting systems, the size of the system needs to be analysed using a detailed approach to ensure a cost-effective solution is developed, as seasonal variations in rainfall can affect sizing requirements even where demand is relatively predictable and consistent.

4.1.2.1.2 Once the storage capacity has been determined, storage tanks should be selected on the basis of working capacity, rather than the total capacity of the container.

4.1.2.1.3 The size of the tank should allow for rainfall variation; however, it should be noted that construction above a certain size based on rainfall for that area provides very limited additional benefit unless stormwater attenuation is intended.

NOTE The size of the tank will also affect how often the stored water overflows. Occasional overflowing can be useful for maintenance and might have benefits for water quality.

4.1.2.2 The simplified approach

4.1.2.2.1 To apply the simplified approach to sizing the rainwater harvesting system for non-potable domestic use, storage capacity should be estimated using the following method.

4.1.2.2.2 First, the roof plan area draining to the storage tank should be established and the annual average rainfall depth for the location of the site should be determined from Hydrological regions of Rwanda for sizing rainwater harvesting systems.

4.1.2.2.3 In most cases, the storage capacity should then be read from the Y axis of Figure 2, using the appropriate diagonal line for the rainfall depth. However, where the site has a large roof plan area and/or is in a region with high annual rainfall, the storage capacity should be determined in relation to the population in the house.

NOTE The simplified approach is based on the following assumptions:

d) relatively constant daily domestic use through the year of 50 litres per day per person for WC flushing and clothes washing;

e) annual average rainfall depth for the site location; and

f) the use of standard tiled pitched roofs for the collection surface.

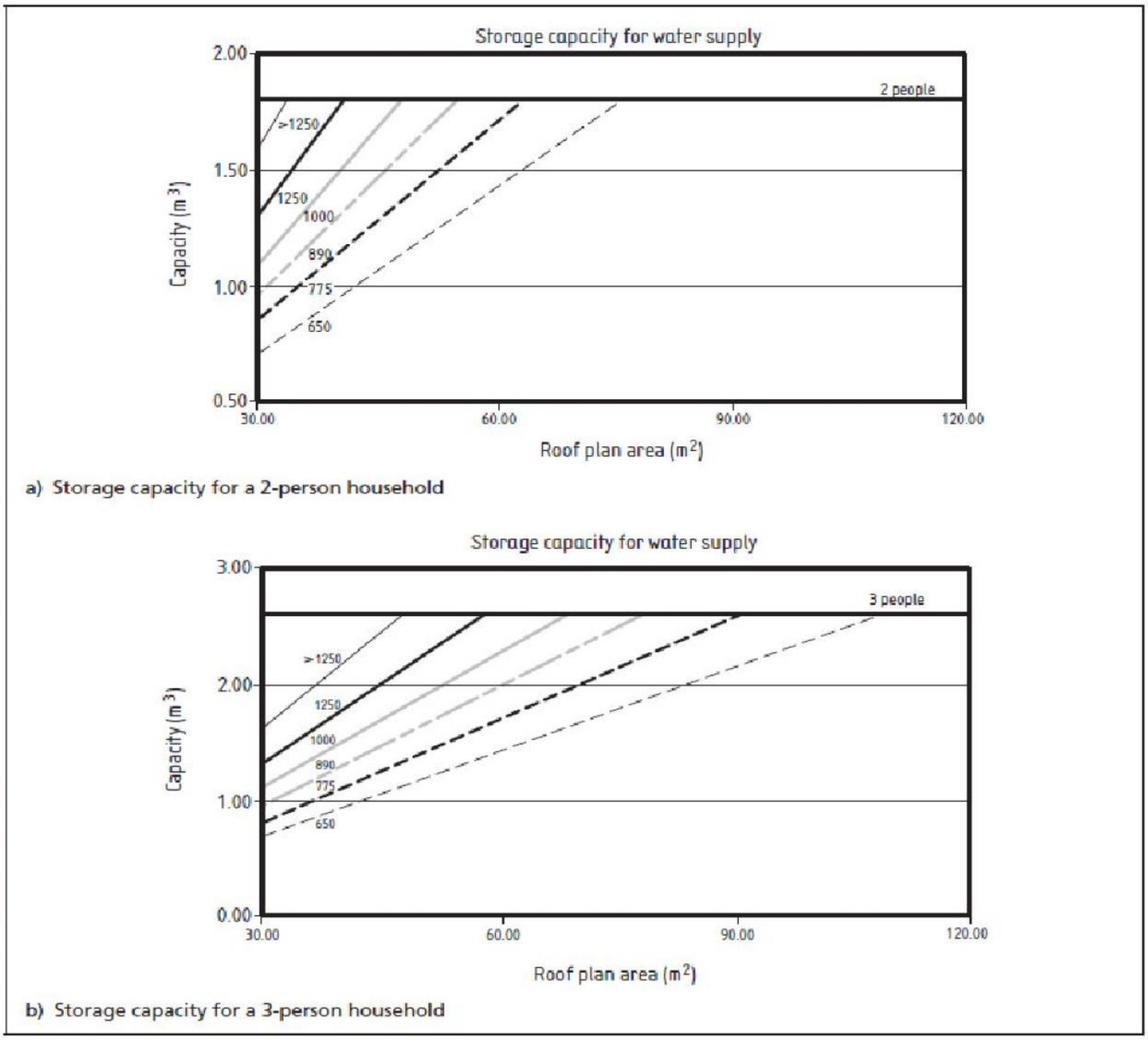

Figure 2 — Storage capacities for non-potable domestic water based on maximum average annual rainfall and roof size for small populations (simplified approach)

4.1.2.3 The intermediate approach

4.1.2.3.1 To apply the intermediate approach to sizing the rainwater harvesting system for non-potable domestic use, storage capacity should be calculated from the following equations and should be the littlest of 5 % of the annual rainwater yield or 5 % of the annual non-potable water demand. 5 % of the annual rainwater yield should be calculated using the equation:

$$\mathbf{Y_R = A \times \textit{e} \times \textit{h} \times h \times 0.05} \qquad (1)$$

where:

Y_R is the annual rainwater yield (L);

A is the collecting area (m^2);

e is the yield coefficient (%);

h is the depth of rainfall (mm);

h is the hydraulic filter efficiency.

5 % of the annual non-potable water demand should be calculated using the equation:

$$D_N = P_d \times n \times 365 \times 0.05 \qquad (2)$$

where:

D_N is the annual non-potable water demand (L);

P_d is the daily requirement per person (L);

n is the number of persons.

4.1.2.3.1 Where the system is to provide both non-potable water for domestic use and stormwater control, the integrated sizing approach given in A.2 should be used to estimate the additional storage capacity needed.

NOTE The intermediate approach is similar to the method described in 4.1.2.2 and thus the results obtained are likely to be similar. Equations are provided to allow a more flexible and accurate facility for calculating the storage needed. The advantage of this is the variables can be modified to reflect the situation being considered.

4.1.2.4 The detailed approach

4.1.2.4.1 The detailed approach should be used to calculate the storage size more accurately for all situations and particularly where:

a) the demand is irregular (e.g. external use, non-residential use, tourism);

b) the yield is uncertain (e.g. due to the use of green roofs, permeable pavements); and

c) costly, larger or complex rainwater harvesting systems are proposed.

NOTE Computer models may be used to simulate the performance of the rainwater harvesting system as accurately as possible. The uncertainty associated with both the demand and the supply needs to be considered using appropriate uncertainty methods.

4.1.2.4.2 To apply the detailed approach to sizing the rainwater harvesting system for non-potable domestic use, storage capacity should be estimated by building a model of yield and demand, which is based on a continuous rainfall time series for a minimum of 3 years and preferably 5 years. This time series should use daily rainfall data for assessing non-potable system storage.

NOTE 1 From an analysis of the results of using a time series for design, the frequency of overflowing can be found. Occasional overflowing allows any floating material to be discharged and offers potential benefits for water quality.

NOTE 2 The analysis also enables an assessment of how much water might be saved annually and the number of days that no rainwater is available, which is particularly useful if there is no back-up supply.

4.2 Collection

4.2.1 Surface

4.2.1.1 When selecting a collection surface, the following factors should be taken into account, as these can affect the quality and quantity of the collected water: the surface's materials and their drainage shall meet the following characteristics:

a) run-off from a green roof will be significantly less than that from a hard roof and is also likely to be affected by a colouration caused by the soil or fertilizers; and

b) the levels of pollution and the risk of contaminants entering the system.

4.2.1.2 Surfaces subject to as little pollution as possible should be used. Ground level or trafficked surfaces can provide large areas for collection and may be used in areas where there is a high demand for non-potable water (e.g. commercial, industrial or public premises). As these surfaces carry a greater risk of pollutants entering the system, they should only be used once a specific risk assessment has been completed (see Clause 8).

4.2.2 Guttering and collection pipework

4.2.2.1 Roof outlets, guttering and pipework should function as an integral part of the whole system, with access for routine maintenance and cleaning.

4.2.2.2 Collection pipework should allow the rainwater to flow from the collection surface to the storage tank by gravity or syphonic action.

4.2.2.3 Pipework should be free draining to avoid stagnation and should prevent contaminated water entering the system from other sources.

4.2.2.4 In addition, sealed gullies should be used at ground level to minimize the risk of pollutants entering the system.

NOTE Conventional rainwater goods and drainage pipes may be used.

4.3 Filtration and treatment

4.3.1 Filtration should be incorporated in the system before the collected rainwater enters the main body of stored water, to prevent debris accumulating in the tank e.g. a filter may be placed in the collection pipework upstream of the tank.

4.3.2 The filter system should include a filter which:

a) is water and weather resistant;

b) is removable and readily accessible for maintenance purposes;

c) has an efficiency of at least 90%; and

d) passes a maximum particle size of <1.25 mm.

4.3.3 Additionally, to prevent any other floating debris from entering the distribution system, the storage tank should be fitted with a calmed inlet.

4.3.4 Where feasible, a floating extraction point from the tank should be used, which is approximately 100 mm to 150 mm below the surface of the water. If floating extraction is not practicable, a fixed extraction

Note 1 Hard roof surfaces are considered the most suitable for rainwater collection, although many common roofing materials may also be used. It is important to note that most collection surfaces are likely to be affected by some form of contamination, e.g. animal and bird faeces, soil, grit, hydrocarbons and various chemicals. These contaminants can have negative effects on the quality of the water collected.

Note 2 A rainwater harvesting system with filtration conforming to 4.3 provides water of a suitable quality for WC flushing, laundry and garden watering in most residential, commercial and industrial situations. However, readers might wish to note that some situations, e.g. where greater human exposure to the water is anticipated or where the water is to be used in public premises, could require higher water quality. In such cases, the system may incorporate treatment processes such as ultraviolet (UV) or chemical disinfection.

Note 3 An additional filter may also be fitted at the extraction point.

4.4 Storage

4.4.1 General

4.4.1.1 The rainwater harvesting system should, as a minimum, include a tank for primary storage, which may be positioned either above or below ground. All tanks should be appropriate to the site (see 5.2.1).

NOTE 1 Tanks are normally prefabricated off site.

4.4.1.2 The tank(s) used in the system should be constructed from materials that create watertight structures without encouraging microbial growth.

NOTE 1 Suitable materials include concrete, glass reinforced plastic (GRP), polyethylene or polypropylene, and steel coated with non-corrodible materials,

NOTE 2 Storage may be accommodated in permeable pavement constructions or other structures, such as geo-cells.

4.4.1.3 All tanks and cisterns, whether used separately or connected to each other in order to create greater capacity, should avoid stagnation, e.g. by ensuring that pipework connections allow the through-flow of water.

4.4.1.4 All tanks and cisterns should have screened ventilation and fitted lids to prevent contamination of the water.

4.4.1.5 All tanks and cisterns should be sited so that the stored water does not attain temperatures that could encourage multiplication of Legionella.

4.4.1.6 Where tanks are positioned above habitable or vulnerable areas, the risk of water leakage should be considered, e.g. bunding, additional drainage, sump pump.

4.4.1.7 The loading of the structure should be taken into account when locating tanks.

4.4.2 Above ground tanks and cisterns

4.4.2.1 Where they are used, above ground tanks and cisterns should be insulated and opaque to minimize the potential problems of warming and algal blooms.

4.4.2.2 The use of disinfection equipment is site and material specific depending on the user's requirements and therefore expert advice is to be taken if such treatment is deemed appropriate.

4.4.2.3 Consideration also needs to be given to the environmental impact of disinfection treatments.

NOTE Above ground tanks are particularly cost effective for retrofit applications.

4.4.3 Below ground tanks

Below ground tanks (and their covers) should be sufficiently rigid to resist likely ground and traffic loadings. Tanks should be installed to resist flotation.

NOTE This might require the use of concrete for backfilling.

4.5 Materials and fittings

4.5.1 The materials selected for the tank and other components should be suitable for the location and temperature ranges anticipated.

4.5.2 All components of the system should be capable of withstanding pH levels as low as 5 for the lifetime of the products.

4.5.3 Consideration should be given to the environmental impact of materials used. Existing resources on site should be utilized, where appropriate, and materials re-used where possible to limit the environmental impacts of the system.

4.6 Power supply

The power supply of the rainwater harvesting system should be readily accessible but also guarded to ensure against the inadvertent isolation or disconnection of electricity.

4.7 Back-up water supply and backflow prevention

NOTE Attention is drawn to the Water Fittings standards which require adequate backflow prevention to be provided so that water supplied from the public mains water supply for domestic uses does not become contaminated.

4.7.1 Back-up water supply

4.7.1.1 The rainwater harvesting system should incorporate a back-up water supply, which may be introduced into a purpose-designed module, incorporating a:

a) break cistern prior to its pump, for delivery to the distribution pipework;

b) an intermediate storage cistern, usually located at high level; or

c) the main collection tank, via a direct connection or discharging into the collection pipework, but not before filtration.

4.7.1.2 The back-up supply should be fitted with a control mechanism which ensures that the amount of water supplied is minimized to that needed for immediate use. It is recommended that this is provided from a make-up module or an intermediate storage cistern.

4.7.1.3 The back-up supply should be sized to allow it to meet the full demand requirements in dry periods.

NOTE 1 It is important to consider the implications of using a back-up supply derived from public mains water during extended dry periods. As the rainwater harvesting system is likely to rely on the back-up supply to satisfy much of the demand, certain applications will not be appropriate.

NOTE 2 For instance, the use of the system for garden watering might be prohibited when water use restrictions (e.g. a hose pipe ban) are in place.

NOTE 3 In order to bring this to the user's attention, advice ought to be included in user instructions, wherever possible.

4.7.1.4 If the back-up supply is to be fed into the main collection tank, careful consideration should be given to tank selection in order to minimize the amount of water needed for continued normal operation before the next rainfall event, e.g. it might be beneficial to use a tank with a small sump area.

4.7.2 Backflow prevention

4.7.2.1 To prevent non-potable water entering the potable or public mains water supply, the back-up supply should be fitted with a backflow prevention device

4.7.2.2 Flow rates, head loss and installation requirements should be taken into account when selecting the backflow prevention device.

4.7.2.3 The backflow prevention device should be located upstream of, or at, the point of delivery where the two supplies come into contact with each other.

4.7.2.4 The impact that a sudden demand from the back-up mechanism might create in operation on the water supply, particularly in large communal systems, should be considered and it is important that supply infrastructure is capable of meeting this increase.

4.7.2.5 The design of the system should ensure that there are no dead legs and suitable turnover of water is achieved, reducing the opportunity for water to become stagnant when not required. Where this is unavoidable, additional backflow prevention in the form of a single check valve should be provided at the branch of the pipework supplying the back-up mechanism to protect the potable water supply.

NOTE Where the backflow prevention device is to be provided by a tundish arrangement and there is a risk of odours venting back into the premises, the use of a waterless trap may be considered downstream of the tundish.

4.7.2.6 When designing for backflow prevention, the appliances to be connected to the system should also be taken into account. Where an appliance with a single fill connection, e.g. washing machine, is to be supplied solely with rainwater, additional backflow prevention might not be required. However, if the appliance needs a supplementary potable source of water, e.g. public mains water.

4.7.3 General

4.7.3.1 For most systems, other than those which distribute the collected rainwater by gravity, a pump(s) should be used to ensure its continual availability.

NOTE The operational safety and hydraulic demand will dictate whether a single pump or multiple-pump systems are needed.

4.7.2.2 The pump should be selected and arranged such that:

a) energy use and noise are minimized;

b) cavitation is prevented; and

c) air is not introduced into the system.

4.7.2.3 The pump should be equipped with dry-run protection, which may be either integral to the pump or provided by an external control device.

4.7.2.4 Surges, water hammer and hunting from the pump should be absorbed and prevented from causing undue high pressures, e.g. by the incorporation of expansion vessels or pressure controls, in order to prevent bursting and excessive draw off.

4.7.4 Pumps outside the tank

4.7.4.1 If installed outside the tank, the pump should have its own self-priming mechanism or a control system which ensures a constant fully primed condition. The suction line to the pump should be laid with a steady gradient upwards towards the pump. The pump should be placed in a well-ventilated location and protected from extremes of temperature, with sound and vibration-free mountings.

4.7.4.2 A non-return valve should be provided in the suction line to the pump in order to prevent the water column from draining down. The pressure line of the pump should be supplied with an isolating valve.

4.7.5 Pumps inside the tank

4.7.5.1 The immersion depth should be in accordance with the pump manufacturer's instructions. The pump should be removable for maintenance purposes.

4.7.5.2 A non-return valve should be provided, with an isolating valve to enable the non-return valve to be maintained.

NOTE A minimum level of water needs to be maintained above the pump inlet in order to prevent damage by sucking in air, sediment or debris.

4.7.6 Multiple pump systems

Multiple pump systems should conform to applicable standards, with a standby pump as necessary.

4.7.7 Pump control unit

4.7.7.1 The pump control unit should:

a) operate the pump(s) to match demand;

b) protect the pumps from running dry; and

c) protect the motor from over-heating and electric overload.

4.7.7.2 The pump control unit should permit manual override.

4.8 Overflow and drainage

4.8.1 An overflow should be fitted to all tanks/cisterns to allow excess water to be discharged during extreme rainfall events. The overflow should be such that any backflow is prevented and vermin are unable to enter the tank/cistern. Overflows fitted to above ground tanks/cisterns should be screened.

4.8.2 The capacity of outlet pipe on the overflow should be equal to or greater than the capacity of the inlet pipe.

4.8.3 For the majority of systems, it is recommended that the overflow is connected to a soakaway.

NOTE 1 For some systems, it might be more appropriate to either pass the flow into the surface water drainage system or allow it to flood. The choice of drainage is dependent on factors such as ground conditions and the consequences of the performance being exceeded. For example, in locations where soils have very low permeability, a soakaway might overfill as a result of large rainfall events although this will result in minimal consequences like infrequent temporary local wet areas and run-off in most instances.

NOTE 2 Where the tank is likely to be full on a regular basis, due to high regional rainfall, the overflow may be located at a lower level and designed to throttle and attenuate the flow. However, if the throttle takes the form of a small orifice, it will be liable to blockage from floating material.

4.8.4 The overflow from the primary storage tank or cistern is likely to contain a small amount of floating material such as leaves washed from filters so, if the water is to be passed to a soakaway, appropriate trapping of the material should be provided.

4.9 Controls and metering

4.9.1 A control unit should be incorporated in the rainwater harvesting system to ensure, as a minimum, that users are aware of whether the system is operating effectively. The control unit should:

a) control pumps and minimize operational wear and energy use;

b) activate the back-up water supply automatically when the minimum water volume in the tank is reached; and

c) provide a volt-free output to enable the system to be linked to a building management system (BMS), where appropriate.

NOTE 1 In order to prevent waste, storage tanks/cisterns with valve-controlled water inputs should have a warning system so any failure is readily noticeable.

NOTE 2 In addition to the control unit, system status monitoring may be incorporated that informs the user of:

a) whether rainwater or back-up supply water is being used;

b) the volume of rainwater used and the volume of water used from the back-up supply. This can be logged and displayed;

c) how full the tank is; and

d) any malfunctions. These should relate to the specific fault, e.g. pump failure, back-up supply failure.

4.9.2 Additional monitoring of the overflow, water quality, tank temperature and other parameters may also be included.

4.10 Distribution

4.10.1 General

4.10.1.1 The system should distribute the collected rainwater by:

a) pumping it from the storage tank directly to the point of use;

b) pumping it from the storage tank to intermediate cisterns near the point of use;

c) using a gravity distribution tank, where practicable; or

d) using a full gravity system, without pumps.

4.10.1.2 Consideration should be given to minimizing the energy used to distribute rainwater.

4.10.2 Distribution pipework and fittings

4.10.2.1 Where practicable, to differentiate rainwater pipework from potable water pipework, a contrasting type or colour of pipe material should be used. The pipework of the rainwater harvesting system, including any below ground back-up supply pipes, should not be blue, as this is the recognized standard used for the potable water supply. It is recommended that pipes are either green, or black and green., In addition, all pipework and fittings should be marked and/or labelled in accordance with applicable regulations.

4.10.2.2 Pipework should be sized to provide adequate flow and pressure, e.g. oversized pipes can cause water quality issues from low flows and excessive pressures can cause undue consumption or leakage.

4.10.2.3 Pipework and fittings should be arranged in such a way as to:

e) be sufficiently strong to resist bursting from the pressure they are to be subjected to in operation;

f) prevent cross-connections with any public mains water or potable water supply; and

g) prevent the trapping of air during filling, and the formation of air locks during operation, that would cause water to be unduly drawn off to clear the system.

NOTE A variety of materials may be used for the distribution pipework, including:

a) polybutylene;

b) cross-linked polyethylene (PE-X);

c) copper;

d) stainless steel containing molybdenum (Mo); and

e) multi-layer barrier pipes. It is important to note that, where polybutylene or cross-linked polyethylene pipes are to be installed below ground, ducting is required.

5 Installation

5.1 General

Installation should be carried out in accordance with instructions given by the manufacturer or supplier. Installation should ensure that all components, including tanks, are accessible for future maintenance and/or replacement of consumable parts. In particular, consideration should be given to the following points:

a) access to below ground tanks;

b) access for personnel to above ground tanks and cisterns, e.g. those located in lofts and roofs;

c) the location of access covers and filters (avoiding the need for access equipment wherever possible); and

d) vehicular access to the site.

NOTE Attention is drawn to local planning and national building regulations, including the Water Fittings Regulations.

5.2 Tank installation

5.2.1 General

5.2.1.1 Prior to installation, any site specific factors that might affect the installation process should be taken into account. Such factors include:

a) groundwater levels;

b) ground strength and stability;

c) land contamination;

d) proximity to trees;

e) proximity to utilities and foundations;

f) shading and temperature; and

g) access routes.

5.2.1.2 All tanks should be fitted with lids that protect the water from contamination and prevent inadvertent human entry. All tanks should be installed so that the stored water does not attain temperatures that should encourage multiplication of Legionella.

5.2.1.3 Any holes that have been cut in a tank, other than those provided by the manufacturer, should be round, so as to not cause any additional stress on the tank that might result in a split. Where non-circular apertures are unavoidable, stress relief should be applied to the aperture to minimize any risk of splitting.

5.2.2 Above ground tanks

5.2.2.1 Above ground tanks should be securely mounted and supported on a firm level base capable of withstanding the weight of the tank when filled with water to the rim.

5.2.2.2 Tanks that are to be installed within a building should be able to withstand any temporary deformation that is required during installation, e.g. when being squeezed through a doorway. Tanks, when installed and correctly supported, should not deform as the water level in the tank changes. Tanks should not be supported by pipework.

5.2.3 Below ground tanks

5.2.3.1 Below ground or partially buried tanks should be installed so that they are not deformed or damaged. Measures, such as concrete surrounds or backfilling and/or controlled filling with water, should be taken to ensure the structural stability of these tanks.

NOTE Issues relating to structural stability include: avoiding flotation, resisting ground pressures and water table fluctuations (structural deformation), resisting vehicle loadings and accommodating differential movement.

5.2.3.2 The area around the access covers of any below ground tank should be impervious and free draining away from the covers to avoid contamination during maintenance and inspection.

5.3 Cistern installation

5.3.1 Where storage cisterns are needed within buildings, these should be installed as for any cold water cistern with appropriate support, insulation and means to prevent contamination. The cistern should be supported on a firm level base capable of withstanding the weight of the cistern when filled with water to the rim. Flexible cisterns should be supported on a flat rigid platform fully supporting the bottom of the cistern over the whole of its area, e.g. close boarding.

5.3.2 Overflows fitted to storage cisterns should be capable of discharging all inflows into the cistern.

NOTE In addition, an automatic supply cut-off device activated by an overflow may be installed to minimize the waste of water.

5.4 Pipework installation

5.4.1 General

5.4.1.1 The pipework connecting the collection surface to the tank should be installed so that water losses are minimized. Pipes should not discharge into open gullies where splashing or additional contamination could occur.

5.4.1.2 Where specified in the design, it should be ensured that an anti-surcharge valve is fitted to the overflow to prevent wastewater backflow.

5.4.2 Labelling and identification

Where two or more water systems, i.e. potable and non-potable, supply one property, all pipework, fittings and points of use for the rainwater harvesting system should be marked and/or labelled in order to facilitate identification, to prevent inadvertent consumption or cross-connection between the systems, and to avoid operating errors.

5.5 Testing and commissioning

5.5.1 The system should be flushed and tested prior to handover to ensure that pipework and containers are watertight and that there are no cross-connections and the manufacturer's recommendations.

NOTE Running coloured dye through the system and carrying out a visual inspection is regarded as a suitable test.

5.5.2 All pipework and fittings should be tested and meet the requirements of applicable standards. The system should also be tested to ensure that wiring is electrically safe and that there is no interference to or from other electrical or electronic equipment, or wiring in the vicinity. Where the installation conforms to this code of practice, a certificate(s) of installation/commissioning should be provided.

6 Water quality

6.1 Frequent water sample testing is not necessary; however, observations for water quality should be made during maintenance visits to check the performance of the system. Tests should then be undertaken to investigate the cause of any system that is not operating satisfactorily and any complaints of illness associated with water use from the system. Sampling for tests should be carried out.

NOTE It is essential that rainwater harvesting systems are designed in a way that ensures the water produced is fit for purpose and presents no undue risk to health.

6.2 Water quality should be measured in relation to the guideline values given in Table 1 for parameters relating to health risk, and Table 2 for parameters relating to system operation, which provide an indication of the water quality that a well-designed and maintained system is expected to achieve for the majority of operating conditions.

Table 1 — Guideline values (G) for bacteriological monitoring

Parameter	Guideline values by use		System type
	Pressure washers and garden sprinklers	Garden watering and WC flushing	
Escherichia coli number/100 mL	1	250	Single site and communal domestic systems
Intestinal enterococci number/100 mL	1	100	Single site and communal domestic systems
Legionella number/litre	100	—	Where analysis is necessary as indicated by risk assessment (see Clause 8)
Total coliforms number per 100 mL	10	1 000 for garden watering and WC flushing	Single site and communal domestic systems

Table 2 — Guideline values for general system monitoring

Parameter	Guideline values	System type
Dissolved oxygen in stored rainwater	>10% saturation or >1 mg/L O_2 (whichever is least) for all uses	All systems
Suspended solids	Visually clear and free from floating debris for all uses	All systems
Colour	Not objectionable for all uses	All systems
Turbidity	<10 NTU for all uses (<1 NTU if UV disinfection is used)	
pH	5–9 for all uses	Single site and communal domestic systems
Residual chlorine	<0.5 mg/L for garden watering	All systems, where used
	<2 mg/L for all other uses	
Residual bromine	<2 mg/L for all uses	All systems, where used

NOTE Water quality will fluctuate particularly following rainfall events when there might be a short-term change.

7 Maintenance

7.1 Human entry into tanks should be avoided, wherever possible. Where entry is essential, it should only be undertaken by trained personnel with personal protection equipment suitable for confined spaces. Maintenance procedures should be in accordance with manufacturer's maintenance recommendations.

7.2 In the absence of any manufacturer's recommendations, the maintenance schedule given in Table 3 should be followed. The maintenance intervals listed here are for initial guidance but the frequency should be modified in the light of operational experience. A log should be kept of inspections and maintenance.

Table 3 — Maintenance schedule

System component	Operation	Notes	Frequency [A)]
Gutters/downpipes	Inspection/ Maintenance	Check that there are no leaks or blockages due to build up of debris; clean the gutters if necessary	Annually
Filter	Inspection/ Maintenance	Check the condition of the filter and clean, if necessary	Annually
Storage tank/cistern	Inspection	Check that there are no leaks, that there has been no build up of debris and that the tank is stable and the cover correctly fitted	Annually
	Maintenance	Drain down and clean the tank	Every 10 years
Pumps and pump control	Inspection/ Maintenance	Check that there are no leaks and that there has been no corrosion; carry out a test run; check the gas charge within the expansion vessel or shock arrestors	Annually
Back-up water supply	Inspection	Check that the back-up supply is functioning correctly, that there are no leaks and that the air gaps are maintained	Annually
Control unit	Inspection/ Maintenance	Check that the unit is operating appropriately, including the alarm function where applicable	Annually
Water level gauge	Inspection	Check that the gauge indication responds correctly to the water level in the tank	Annually
Wiring	Inspection	Visually check that the wiring is electrically safe	Annually
Pipework	Inspection	Check that there are no leaks, that the pipes are watertight and that overflows are clear	Annually
Markings	Inspection	Check that warning notices and pipework identification are correct and in place	Annually
Support and fixings	Inspection/ Maintenance	Adjust and tighten, where applicable	Annually
UV lamps	Inspection/ Maintenance	Clean and replace, if necessary	Every 6 months

[A)] These frequencies are recommended if no information is given by the manufacturer.

8 Risk management

8.1 General

8.1.1 A risk assessment should be carried out to determine whether the system is safe and fit for purpose. This should take place when the system is being designed.

8.1.2 The risk assessment should consider the design, installation, testing and commissioning, operation and maintenance of the system, including water quality, structural stability, electrical safety and access provision.

8.1.3 The risk assessment should consider the effects of exposure to and the potential impacts of, the system on: people, including operators, installers, maintainers, a) and water users, particularly those who might be more susceptible to poor water quality (e.g. children or the elderly);

a) the environment, including domestic and feral animals, birds and fish, plants, water courses and groundwater; and

b) physical assets, including buildings, foundations, drains, paved areas and gardens.

8.1.4 The risk assessment should be used to identify additional actions, process improvements or enhanced controls that can reduce risks in a cost-effective manner.

NOTE The use of rainwater for WC flushing and general garden watering is considered to be a low-risk application due to the low level of human exposure. However, there are some factors, such as the use of pressure washers and garden sprinklers that increase the extent of exposure through aerosols, thus making risk assessment necessary.

8.2 Water quality

The risk assessment should consider potential sources of contamination of water entering or already in the system. The risk assessment should be used to identify the need for any further water quality control measures, including additional monitoring, for systems where a ground-level and/or highly trafficked collection surface is to be used.

NOTE The World Health Organization endorses the "water safety plan" approach to protect the safety of water supplies. This involves a system of risk assessment and risk management.

Bibliography

[There is no bibliography]

ICS 13.060.99